Bridging the Digital Divide: Fostering STEM Education for Digital Economy Leadership

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Executive Summary

As BRICS countries strive to build a digital economy, these nations must prepare their populace for the 'future of work.' Digital economies tend to create middle to high-skilled jobs. This is problematic as many workers are trapped in low-skill occupations and lack the expertise to adequately participate in a digital economy. A digital economy requires a population that is literate in Science, Technology, Engineering, and Mathematics (STEM). While BRICS has made progress in educating their populace in these fields, they still have a long way to go. More STEM graduates (especially women) must be produced to maintain and create a digital economy. This policy brief maps out strategies for BRICS countries to increase STEM participation.

Keywords: BRICS, STEM, Education, digital economy

Introduction

The BRICS countries, namely Brazil, Russia, India, China, and South Africa, represent a collective of emerging economies that have identified the potential opportunities brought forth by the digital revolution. In attempts to take advantage of the digital revolution, BRICS countries have made multiple national strategies to develop a digital economy (ITC, 2022).There is no strictly agreed-upon definition of what constitutes a 'digital economy' among these countries, but they all loosely agree that a digital economy pertains to an economic system that primarily uses digital technologies, information technology, big data, e-commerce; internet of things to produce goods and services (ITC, 2022).

BRICS countries have made significant strides towards a digital economy; examples of this can be seen in Brazil, where the digital economy accounted for 22% of their GDP in 2016 (ITC, 2022). In Russia, during the period of 2015-2017, 4% of the GDP arose from the digital economy with potential for exponential growth. While in India and China, the digital economy in 2019 and 2020 stood at 6.9% and 7.8% of the GDP, respectively (ITC, 2022).

The proliferation of a digital economy alters the operations of industries and job profiles within BRICS economies. Countries with a robust digital economy tend to create middle to high-skill job profiles. There is an urgent need for BRICS countries to lay out a unified strategy to upskill their populace to prepare and maintain a vibrant digital economy (ITC, 2022). For a digital economy to thrive, BRICS countries must focus on educating their populace in STEM skills. In India, it is envisaged that its digital core sector will create 60 to 65 million new jobs by 2025, that will require some STEM skills (Gupta et al., 2019). In South Africa, the digital economy is forecasted to create 1.2 million jobs by 2030, that necessitate a certain level of STEM literacy (Chiu et al., 2019).

There is a stark digital divide within each of the BRICS countries, and one of the reasons contributing to this divide is that a notable part of their populace lacks the skills required for the digital age of employment. To bridge this gap, this policy brief aims to lay out a blueprint for increasing STEM literacy in the BRICS populace.

Overview of the current state of STEM education in each BRICS country

Historically, Brazil has faced challenges in STEM education, primarily due to socio-economic disparities and under-resourced public education systems. However, in recent years, the country has shown a commitment to improving STEM education (Horta, 2018). For instance, the Brazilian government has increased investments in education technology and teacher training, especially in the fields of science, mathematics, and ICT (Valente and Almeida, 2020). One of the biggest challenges remains the lack of qualified STEM teachers with inadequate training and excessive workload. There is also a lack of resources and infrastructure for STEM education (Marginson et al., 2013; Valente and Almeida, 2020). The Brazilian workforce only consisted of 2.8% of STEM occupations in 2019, but unfortunately, women are heavily underrepresented, as only 26% of STEM workers in Brazil were women in 2019 (Machado, 2021). In 2022, only 17.5 percent of all graduates in Brazil had completed degrees in STEM fields (Buchholz, 2023; World Economic Forum, 2023). Only 36.64 percent of all STEM degrees being obtained by women, compared to 63.36 percent of all STEM graduates being men in 2022 (Gender Gap Index, 2022).

Moreover, Russia has a strong tradition of scientific research and development, and there are many high-quality STEM schools and universities. Russian students often perform well in international math and science competitions, indicating the effectiveness of their STEM education (Centre for Security and Emerging Technology, 2019). However, there are some challenges to STEM education in Russia. One of the biggest challenges is the lack of qualified STEM teachers. There is also a lack of resources and infrastructure for STEM education (Avdeenko, Sabirova, and Konyushenko, 2021). Despite these challenges, there are some positive signs for STEM education in Russia. The government has increased investment in STEM education, and there is a growing interest in STEM subjects among students. There are also several STEM-focused initiatives and programs being implemented in Russia, such as the Presidential Decree on the Development of Artificial Intelligence (Centre for Security and Emerging Technology, 2019). Only 4% of the Russian workforce was employed in STEM occupations in 2018 (Avdeenko, Sabirova, and Konyushenko 2021). Russia actively encourages women to participate in STEM education, however, they remain underrepresented within these fields (Oblova, Gerasimova, and Sishchuk, 2020).

Furthermore, STEM education in India is highly valued. The government has made STEM education a priority, and there is a strong focus on producing high-quality STEM graduates. There are many high-quality STEM schools and universities in India, and the country has a strong tradition of scientific research and development. The government has made efforts to improve STEM education and introduced policies like the National Education Policy 2020, which focuses on the improvement of education with a large focus on STEM education. However, there are some challenges to STEM education in India. One of the biggest challenges is the large number of students. India has a population of over 1.3 billion people, and the number of students enrolled in STEM programs is growing rapidly (Bhattacharyya, 2020; Buchholz, 2023). This puts a strain on resources and educational infrastructure. Further challenges include outdated curricula, lack of practical application in education, and disparities in access to quality education. Efforts are being made to modernize the education system, with a push towards digital learning and updated, more practical STEM curricula (Qureshi and Qureshi, 2021). India produces a large share of STEM graduates, as in 2022, 34 percent of all graduates in India had completed degrees in STEM fields (Buchholz, 2023; World Economic

Forum, 2023). However, women remain underrepresented in many STEM professions in India. For example, the number of workers in the information technology sector stands at 4.4 million; however, less than 10 percent of female employees are in top-level positions (NASSCOM, 2020). Additionally, in full-time employment of science researchers in 2019, women only occupied 16.6 percent of job positions (Amirtham and Kumar, 2023).

Similarly, STEM education in China is highly valued. The government has made STEM education a priority, and there is a strong focus on producing high-quality STEM graduates. There are many high-quality STEM schools and universities in China, and the country has a strong tradition of scientific research and development (Loyalka et al., 2021). In recent years, China has made significant investments in STEM education. The government has built new STEM schools and universities, and it has also provided funding for STEM research and development (Han, Appelbaum, and Rosenbloom, 2018). China's President, Xi Jinping, has set a goal of ensuring China becomes a leading innovator by 2050 and has ensured the government invests heavily in becoming one of the leading countries in STEM education. In 2017, 8 million students graduated in STEM fields from Chinese universities (Han, Appelbaum, and Rosenbloom, 2018). While China has made efforts to close the gender gap in STEM education, they still have a long way to go to close the gender gap within the labour market, as women are underrepresented in plenty of STEM job positions (Lingyu et al., 2022). For example, in 2015, only 26.56 percent of women were accounted for in STEM research and development personnel (Yang and Gao, 2019).

Lastly, South Africa faces significant challenges in STEM education stemming from historical inequalities and resource limitations. STEM education in South Africa is also less developed than in other BRICS countries. Despite these issues, the government has committed to improving education, with a focus on increasing access to and quality of STEM education in the country (Sikhosana, Malatji, and Munyoro, 2023). The government has made some efforts to improve STEM education, but there are still significant challenges. One of the biggest challenges is the lack of qualified STEM teachers. There is also a lack of resources and infrastructure for STEM education. Equal access to education is another issue that continues to plague the education system, as there are large disparities in the quality of education accessed in schools around the country (Mkhize, 2023). Despite these challenges, there are some positive signs for STEM education in South Africa. The government has increased investment in STEM education, and there is a growing interest in STEM subjects among students. There are also a number of STEM-focused initiatives and programs being implemented in South Africa (Sikhosana, Malatji, and Munyoro, 2023). However, despite the efforts, more work needs to be done to improve STEM participation and gender equity in STEM. Only 42.76 percent of all STEM degrees being obtained by women, compared to 57.24 percent of all STEM graduates being men in 2022 (Gender Gap Index 2022).

Unlocking the Future: A Compelling Case for STEM Policy Emphasis

There is a direct positive correlation between a STEM populace and economic development. Countries with STEM-oriented economies are superior to countries with lower STEM-oriented economies (Rothwell, 2013; Costa, 2019). The digital economy depends on innovation, and STEM professions drive technological innovations. STEM markets tend to boost economies' productivity through technological innovation and create new products and industries. Employment opportunities in STEM fields are anticipated to experience fast growth rates relative to non-STEM fields. Professions that require STEM literacy host 75% of the fastest-growing professions globally (Makgato, 2019). Research suggests that to meet the high job demand in these STEM occupations, BRICS countries need to actively educate more of their populace in STEM fields.

BRICS countries are challenged by many social issues, ranging from epidemic prevention and control, climate change, poverty, healthcare, and more. These challenges need technological and scientific expertise to overcome them. By encouraging STEM education in these countries, local skills will be developed to create innovative solutions to solve local problems and thus improve the standard of living for their citizens. An example of locally driven solutions can be seen in China, which has aggressively taken steps towards 'digital health care' with technologies such as health information technologies, artificial intelligence, 3D printing, and Big Data to improve medical services (Odonkor, 2023). However, digital healthcare advancements are not uniform amongst BRICS countries, and one of the reasons for that is due to the disparity of STEM literacy within the populace.

BRICS is a partnership of emerging economies that benefits from mutually beneficial knowledge exchange. Thus, bolstering STEM skills would further create an opportunity for collaboration in research and development among these countries. By leveraging diverse expertise, these emerging economies can tackle complex collaborative projects. An example of this is the BRICS Vaccine Research and Development Centre, which was a platform created to share knowledge and expertise in vaccine research (DHET, 2022). These collaborations would benefit from a larger pool of STEM graduates.

There is an urgent need for BRICS countries to improve the underrepresentation of women in STEM fields. This will reduce the gender gap in these areas and the gender wage gap within the labour market. Women-led businesses have been argued to face more significant challenges adopting technological advancements (UNCTAD, 2021). Women are approximately half the population in these countries and equipping them with technical skills allows these countries to tap into a larger talent pool. Women tend to bring unique perspectives and experiences to problem-solving, thus bringing novel insights and innovative solutions in STEM. More women should be assisted into the digital economy (UNCTAD, 2021).

Lastly, STEM fields often provide technological breakthroughs. A strong STEM populace will increase BRICS countries' self-reliance on technological innovation and reduce reliance on importing technology from Western countries.

Identifying strengths and weaknesses in existing STEM education initiatives

Opportunities

The BRICS countries have several strengths in STEM education and research. These include:

- Large populations: The BRICS countries have a combined population of over 3 billion people. This gives them a large pool of potential STEM students and researchers. This large population base fostered to partake in STEM fields, will lead to greater innovation, technological advancements, and research output.

- A young population: The BRICS countries possess a predominantly young population. A youthful demographic provides these nations with the opportunity to cultivate a new generation of skilled workers in STEM.

- Rapid economic growth: The BRICS countries are some of the fastest-growing economies in the world. This means that they have a lot of resources to invest in STEM education and research.

- Government support: The governments of the BRICS countries are supportive of STEM education and research. They have invested in STEM schools and universities, and they have also provided

funding for STEM research and development. An increase in governmental support in STEM fields will assist in further developing STEM fields.

Challenges

The BRICS countries face several noteworthy challenges. These include:

- Lack of qualified STEM teachers: BRICS countries struggle with a shortage of trained STEM teachers due to inadequate training programs and low salaries. This shortage hampers students' learning experiences and preparedness for STEM careers.
- Poor infrastructure and resources: Many schools in BRICS nations lack essential STEM facilities, such as well-equipped laboratories and modern technology. Rural schools, particularly, face significant challenges due to insufficient funding and neglect, hindering students' access to hands-on learning experiences.
- Low interest in STEM subjects among students: Despite the demand for STEM skills, students in BRICS countries often show limited interest in STEM subjects due to outdated teaching methods and misconceptions about STEM careers. Addressing this challenge requires innovative approaches to engage students and promote the relevance of STEM education.
- Gender disparities in STEM education: Gender disparities persist in STEM education across BRICS countries, with women underrepresented in these fields due to societal norms and biases. Bridging this gap requires efforts to promote inclusivity, provide support for female students, and challenge gender stereotypes.

Policy Recommendation

Given the challenges and opportunities presented above, the BRICS countries have a number of policy considerations to make, in order to enhance their role in advancing STEM. They are as follows:

1. BRICS needs to invest more in uniform structures that target training programs that encourage women's participation in STEM. These programs include extracurricular activities, mentorship programs, promoting female STEM role models, and scholarships.
2. BRICS countries should form a STEM research and development fund to support collaborative STEM initiatives and bolster knowledge sharing. This fund would support a BRICS STEM education network to share best practices in STEM education. This would assist in unified STEM development.
3. BRICS countries must allocate larger budgets to rural schools in impoverished areas and equip them with STEM laboratories and equipment. This policy will close the disparity between the best and worst performing schools in their respective countries.
4. BRICS countries need to allow teachers who intend to train in STEM subjects to study for free. This is to encourage more teachers to be trained in STEM fields.

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